Research Article

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Investigation of *Solanum Lycopersicum* Capped Zinc Oxide Nanoparticles for Cancer Application

M. A. Nasreen Baanu, S. Shanmathi*, V. Kalaiselvi, V. Ramya, P. Sudha, N. Vidhya
Department of Physics, Navarasam Arts & Science College for Women, Erode, TN, India
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*shanmathi.gsm@gmail.com

ABSTRACT

The present work deals with the synthesis and characterization of ZnO nanoparticles using Solanum lycopersicumextract. The synthesized nanoparticles were characterized by various techniques such as XRD, FTIR, SEM, EDAX. The X-ray diffraction (XRD) Pattern analysis reveals the presence of crystalline nature in Zinc oxide nanoparticles. The functional groups were analyzed using Fourier Transform Infrared Spectroscopy (FTIR). The morphological structure of the sample was analyzed using Scanning Electron Microscopy (SEM). The purity and elemental composition of the sample were identified by Energy Dispersion X-ray Diffraction (EDAX) analysis.

Keywords: Microwave method; Solanum lycopersicumextract; Sodium hydroxide; Zinc nitrate; Zinc oxide.

1. INTRODUCTION

Nanotechnology is the study and application of very small things and can be used across all the other science fields, such as chemistry, biology, environmental science, physics, materials science, and engineering (Bharathi *et al.* 2020). A nanoparticle is a microscopic particle with at least one dimension less than 100 nm. Nanoparticle research is currently an area of intense scientific research due to a wide variety of potential applications in biomedical, optical, and electronic fields (Farood *et al.* 2017). A nanoparticle is a small particle that ranges between 1 to 100 nanometers in size. Undetectable by the human eye, nanoparticles can exhibit significantly different physical and chemical properties to their larger material counterparts (Surya *et al.* 2020).

The tomato (*Solanumlycopersicum*) is a botanical fruit. It is shiny and smooth. It has many small seeds. It is also very good for health. There are many different types of tomatoes available. Including tomatoes in the diet can help protect against cancer, maintain healthy blood pressure, and reduce blood glucose in people with diabetes.

Tomatoes contain key carotenoids such as lutein and lycopene. These can protect the eye against light-induced damage. Eat more tomatoes by adding them to wraps or sandwiches, sauces, or salsas. Alternatively, eat them cooked or stewed, as these preparation methods can boost the availability of key nutrients. Tomatoes are in the top ten fruits and vegetables for containing levels of pesticide residue. Tomatoes are an excellent source of vitamin C and other antioxidants. With these components, tomatoes can help combat the formation of free radicals. Free radicals are known to cause cancer (Monawara *et al.* 2020).

A recent study in the journal *Molecular Cancer Research* linked the intake of high levels of beta-carotene to the prevention of tumor development in prostate cancer. Tomatoes also contain lycopene. Lycopene is a polyphenol, or plant compound, that has been linked with one type of prostate cancer prevention.

Fig. 1: ***Solanumlycopersicum***

A study of the Japanese population demonstrates that beta-carotene consumption may reduce the risk of colon cancer. Fiber intake from fruits and vegetables is associated with a lowered risk of colorectal cancer. Diets rich in beta-carotene may play a protective role against prostate cancer. Further human-based research is needed to explore the possible roles of lycopene and beta-carotene in preventing or treating cancer (Sharmila *et al.* 2019). Zinc oxide is an inorganic compound with the formula ZnO. It is a white powder that is insoluble in water. ZnO is present in the Earth's

crust as the mineral zincite. Zinc oxide is commonly found in medical ointments where it used to treat skin irritations. In more recent times, zinc oxide has transcended to use in semiconductors, concrete use, ceramic and glass compositions, and even cigarette filters.

Zinc oxide also has antibacterial and deodorizing properties. For this reason, it is employed in medical applications such as baby powder and creams to treat conditions such as diaper rash, other skin irritations, and even dandruff. Due to its reflective properties, it is also used in sunblocks and can often be seen on the nose and lips of lifeguards at the beach (Shreema *et al.* 2020).

2. MATERIALS & METHODS

2.1 Materials Required

The entire chemical such as Zinc nitrate, distilled water, and other sodium hydroxide ingredients utilized in this work are purchased from Erode, Tamilnadu. The tomato (*Solanum lycopersicum*) was collected from in and around Erode, Tamilnadu, India.

2.2 Preparation of Tomato Extract

Take 50g of tomatoes (*Solanum lycopersicum*) was washed them with double distilled water. The skin was removed from the tomato, and the whole mass was squeezed to get the juice. This juice was dissolved in 100ml of distilled water and filtered using a Whatman filter paper. Then it was stored at room temperature for further use.

2.3 Preparation of Zinc Oxide Nano Particle

Zinc nitrate was used as a precursor for the synthesis of ZnO Nanoparticles. 10g of zinc nitrate was dissolved in 50ml of distilled water and stirred for 30 minutes. The mixture was boiled at 80^{o}C for 5 min. Then add NaOH solution drop-wise to maintain pH as 12. This mixture was continuously stirred for half an hour—the synthesized zinc oxide sample aged for 24 hours. Thus the settled precipitate was washed with double distilled water, and the final product was kept in a microwave oven at 350W for 30 minutes. The dried sample was grained using a motor to get a fine nanopowder of tomato capped zinc oxide.

3. CHARACTERIZATION TECHNIQUES

3.1 XRD Analysis

The prepared samples were analyzed using XRD (X – ray Diffraction) technique. This XRD pattern predicts the lattice parameter (a and c), unit cell volume, and crystalline size of the sample. The lattice parameter of the sample was calculated using the following equation:

$$1/d^2 = (4(h^2+hk+k^2)/3a^2) + (1^2/c^2))$$

Where d is the spacing between the planes, a and c are the lattice parameter. The unit cell volume (V) of the sample was described using the given equation:

$$V = (\sqrt{3}/2) + a^2+c^2$$

The average crystalline size of the sample was determined by using Scherrer's formula.

$$D = K\lambda /\beta\cos\theta$$

Where D denotes the average crystalline size of the sample, K represents the broadening constant, λ denotes the wavelength of CuKα radiation source (1.54Å), β represents the full width at half maximum, and angle of diffraction is denoted by θ.

3.2 Fourier Transform Infra-Red Spectroscopy (FTIR)

Fourier Transform Infrared Spectroscopy relies on the fact that most molecules absorb light in the infra-red region of the electromagnetic spectrum. This absorption corresponds specifically to the bonds present in the molecule. The frequency range is measured as wave numbers typically over the range 4000 – 600 cm-1. It is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid, or gas. This simultaneously collects high-spectral-resolution data over a wide spectral range. This confers a significant advantage over a dispersive spectrometer, which measures intensity over a narrow range of wavelengths at a time (Vijayakumar *et al.* 2020).

3.3 Energy Dispersive X-Ray Spectroscopy (EDAX)

The Energy Dispersive X-ray (EDAX) microanalysis is a technique of elemental analysis associated with electron microscopy based on the generation of characteristic X-rays that reveals the presence of elements present in the specimens. The EDAX microanalysis is used in different biomedical fields by many researchers and clinicians. Nevertheless, most of the scientific community is not fully aware of its possible applications. The spectrum of EDAX microanalysis contains both semi-qualitative and semi-quantitative information. EDAX technique is made useful in the study of drugs, such as in the study of drug delivery, in which the EDAX is a vital tool to detect nanoparticles (Yasotha *et al.* 2020).

4. RESULTS

4.1 XRD Analysis

The X-ray powder diffraction (XRD) pattern of ZnO nanoparticles was shown in Fig. 2. The XRD pattern

confirms that the crystalline structure with all possible peaks. The peaks in XRD pattern were observed at 2θ values, which correspond to the lattice planes 101, 102,103, according to the database. From XRD results in the crystalline size of the prepared sample was identified.

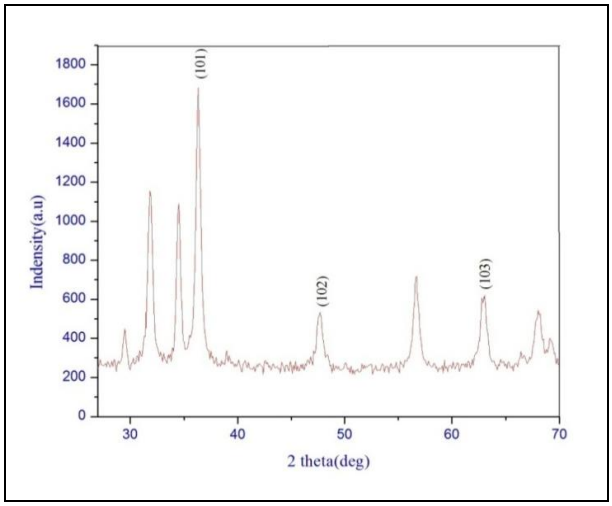

Fig. 2: XRD Spectrum of ZnO Nanoparticles

4.2 FTIR Analysis

Infrared spectroscopy gives information on molecular vibration or more precisely, on the transition between vibration and absorption energy levels. Absorption of radiation results in the excitation of bond deformation. Either stretching or bending vibration occurs at certain quantized frequencies.

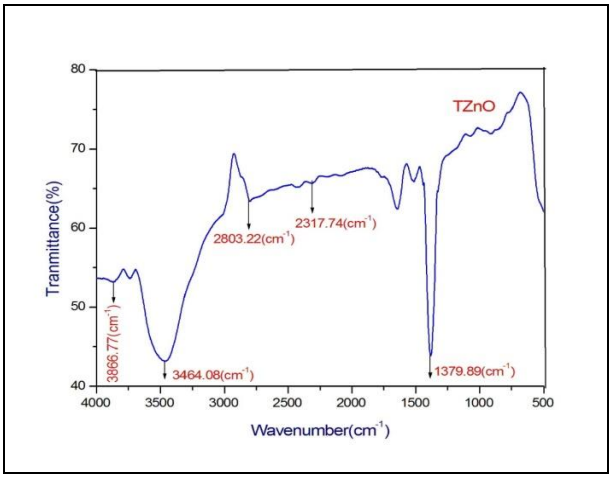

Fig. 3: FTIR Spectrum of ZnO Nanoparticle

The FTIR spectra predict the characteristic bands present in the sample. The observed peak resulted from the ZnO microwave method at 3866.77(cm^{-1}) to 869.80(cm_{-1}). The broad peak was absorbed in 3866.77cm^{-1} (Alcohol), which be in contact with O-H stretching banded. The absorption in the region 3464.08 cm^{-1} due to the associative N-H stretching. C-H stretching confirms the absorption peak of 2803.22cm^{-1} (Alkynes). The region at 2317.74 cm^{-1} for absorption of OH stretching. N=O stretching from the absorption the peaks at 1379.89cm^{-1}(Nitro). Then FTIR spectrum absorbs the peak at (TZnO)3449.87cm^{-1} were calculated with the stretching vibrations of N-H (Amine)bond. The present groups of TZnO (Tomato capped Zinc Oxide) were analyzed, shown in table 2.

Table 1. XRD Analysis of ZnO Nanoparticles

Sample Name	2θ (deg)	FWHM (deg)	D (Å)	Intensity (count)	Crystalline Size(m)	Average Crystalline Size	hkl	Lattice constant		Lattice Cell Volume ($Å^3$)
								a=b	C	
	36.2895	0.55290	2.4735	892	15.12245		101			47.48
TZnO	47.6203	0.64580	1.9080	199	13.44745	14.53997	102	3.23	5.22	46.66
	62.8906	0.61880	1.4765	260	15.05002		103			47.71

Table 2. FTIR Region of ZnO Nanoparticle

S.No	Sample name	Wave Number(cm^{-1})				
		O-H Stretching vibration(banded)	N-H Stretching vibration	C-H Stretching vibration	O-H Stretching vibration(free)	N=o Stretching vibration
1.	TZnO	3866.77	34.64.08	2803.22	2317.74	1379.89

4.3 Energy Dispersive X-Ray Spectroscopy Analysis (EDAX)

EDX analysis is used to indicate the elemental composition present in the sample. Zinc and oxide peaks are observed and indicating the presence of ZnO Nanoparticles.

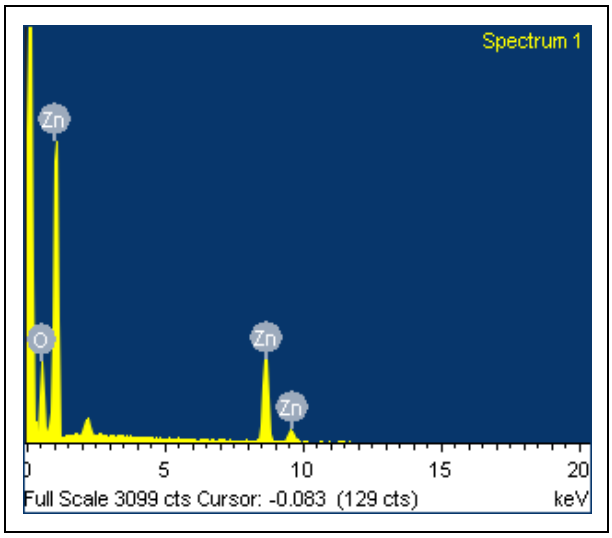

Fig. 4: EDAX Spectrum of ZnO Nanoparticles

The x-axis indicates the ionization energy, and the y-axis shows the number of counts. Table 4.3 shows the EDX analysis of ZnO nanoparticles with 38.07% of zinc and 61.93% of oxides which confirms the elemental composition of zinc oxide nanoparticles. Fig 4 shows the peaks which were identified as zinc and oxide.

Table 3. EDAX Analysis of Zinc Oxide Nanoparticle

Elements	Intensity	Weight	Atomic Weight
O	1.1430	28.48	61.93
Zn	0.9204	71.52	38.07
	Total		100

4.4 Scanning Electron Microscope (SEM)

SEM was used to determine the size and structure of the sample. SEM studies were revealed to visualize the size and shape of zinc oxide nanoparticles and show the typical bright field micrograph of the synthesized zinc oxide nanoparticles. The figure 5 shows the SEM morphology of ZnO nanoparticles prepared green synthesis method.

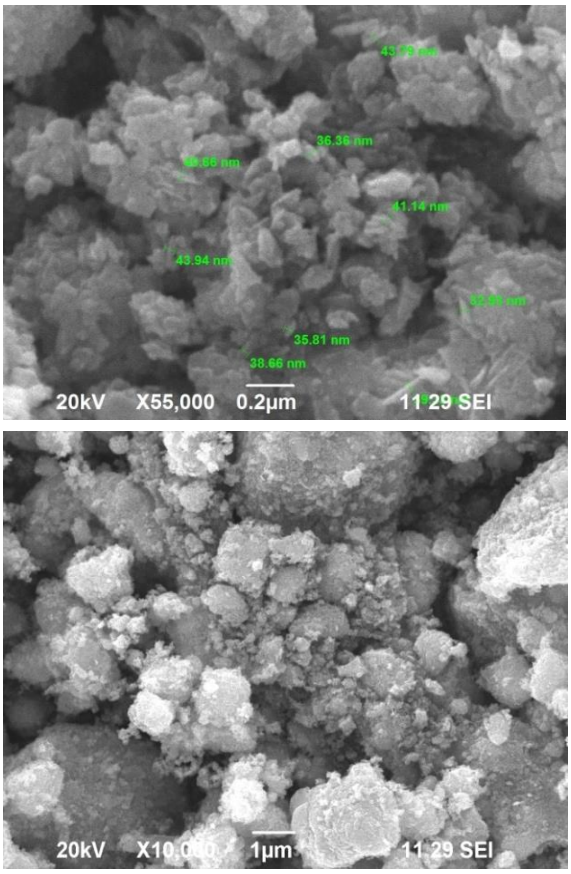

Fig. 5: SEM image of ZnO Nanoparticles

5. CONCLUSION

The present work deals with the ZnO Nanoparticles with and without capping agent *Solanum lycopersicum*extract was synthesized by microwave irradiation method. The theXRD pattern indicates the crystalline size of the sample, the crystalline size of 14.5nm.SEM analysis reveals the cluster shape partial morphology in the surface. FTIR spectrum confirms the function group of the sample. Finally, EDAX analysis predicts the presence of chemical components present in the sample. Thus the synthesized samples can be applied in the field of medicine for cancer treatment.

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